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[001] ELECTROMAGNETIC SELECTION DEVICE FOR A TWO-STAGE PLANETARY GEAR SET

[002]

[003]

[004] The invention relates to an electromagnetic selection device for a two-stage planetary gear set in accordance with the preamble of claim 1 disclosed in DE-A 199 17 673.

[005]

[006] The electromagnetic selection device made known by DE-A 199 17 673 consists of one electromagnet located outside the housing of the planetary gear set and having one movable armature, the movements of which are transmitted from outside via a lever mechanism by the transmission housing to a sliding sleeve situated in the transmission housing. By the electromagnetic lever mechanical control, the sliding sleeve is moved to a first and to a second switch position in which with the housing are coupled either ring gear and sun gear for a direct through drive from input to output or the ring gear to achieve a ratio. The already known device has more potentials with regard to compact design and play-free transmission of motion. The housing aperture needed for the lever mechanism and sealing problems associated therewith are not advantageous.

[007] The problem on which the instant invention is based is to improve an electromagnet selection device of the kind mentioned above with regard to a compact and closed design and to a transmission mechanism as play free as possible, specially between electromagnet and sliding sleeve.

[008] The solution of said problem results from the features of claim 1. It is of advantage here that any lever mechanism for motion transmission between electromagnet and sliding sleeve is eliminated thereby reducing the number of parts, since the armature is directly fastened - via a bearing - upon the sliding sleeve. Eliminated is also any play necessarily associated with a lever mechanism. Since the armature is situated within the transmission housing,

an aperture is eliminated and therewith a possible point of leakage in the wall of the transmission housing.

[009]

[010] In an advantageous development of the invention, the armature is designed as an annular part, that is, it engages over its whole periphery on the sliding sleeve - an eventual misalignment being thus extensively ruled out.

[011] According to an advantageous development of the invention, the armature has slopes which correspond with slopes of counterparts of the armature, that is, the armature forms with its counterparts a sliding cone. The armature slopes minimize over the sliding path the air gap between armature counterpart and armature. Thereby is achieved the advantage of a uniform electromagnetic tightening force (constant tension flow over the whole switching path).

[012] According to one other advantageous development of the invention, the whole electromagnetic selection device is designed as front-mounted structural part which is inserted in the transmission housing where it is fastened. This adds advantages both in assembly and production and also the advantage of a compact closed design for the entire planetary gear set. The sliding sleeve is encased by the structural unit thus reducing churning losses.

[013] According to another advantageous development of the invention, to the prefabricated structural unit is added on its front side one brake disc with inner coupling gears which together with the structural unit is inserted in the transmission housing where it is fastened. Sliding sleeve and brake disc, the respective coupling teeth of which correspond with each other, are thus already centered during the assembly.

[014]

[015] One embodiment of the invention is shown in the drawing and described in detail herebelow. In the drawing:

[016] Fig. 1 is section through a planetary gear set with selection device;

[017] Fig. 2 is a separate representation of the electromagnetic selection device of Fig. 1; and

[018] Fig. 3 is a perspective representation of the electromagnetic selection device as pre-assembled structural unit.

[019]

[020] Fig. 1 shows a two-stage planetary gear set 1 with one input shaft 2 and one output shaft 3 supported on respective covers 4, 5 of a transmission housing 6. The input shaft 2 is positively connected via a driving sleeve 7 with a sun gear 8 which meshes with planetary gears 9 of a planet carrier 10 which for its part is positively connected with the output shaft 3. The planetary gears 9 mesh with a ring gear 11 which is rotatably supported relative to the planet carrier 10 or the sun gear 8. The ring gear 11 has an outer coupling gearing 12 which can be made to engage with, or disengage from, an inner coupling gearing 13 of a sliding sleeve 14. The sliding sleeve 14 can further be made to engage with, or disengage from, an outer coupling gearing 15 of the driving sleeve 7. The sliding sleeve 14 has also an outer coupling gearing 16 which by axial displacement of the sliding sleeve 14 can be made to engage with, or disengage from, an inner coupling gearing 17 of a brake disc 18 fixed to the housing. The sliding sleeve 14 supports itself, via a grooved ball bearing 19, opposite to an electromagnetic selector unit 20 which, by way of fastening bolts 21, together with the brake disc 18 is fastened on the transmission housing 6 coaxially to the input shaft 2.

[021] The selector unit 20, more specifically described herebelow, controls the axial motion of the sliding sleeve 14 for three positions, that is, a neutral position and two switch positions. In the first switch position, shown in the drawing, the sliding sleeve 14 couples the ring gear 11 and the driving sleeve 7; in this "direct gear" the reduction ratio is 1:1. To reach the second switch position, the sliding sleeve 14 is axially moved to the right by the selector unit 20 until the outer coupling gears 16 engage with the inner coupling gears 17 of the brake disc 18. The ring gear 11 is then decelerated or held stationary relative to the housing 6 via

the sliding sleeve 14. The rotational speed of the input shaft 2 is then geared down.

[022] The sliding sleeve has on its external periphery grooves (not shown) in which locking bolts engage to keep the sliding sleeve in one of the switch positions.

[023] The locking bolts are movable by an electromechanical actuation unit 29 radially to the transmission main axle where they engage under tension in the grooves and, by an electromagnet of the actuation unit 29, are drawn radially outwards so as to unlock the sliding sleeve.

[024] The electromagnets of the selector unit and of the actuation unit 29 must therefore be controlled, that is, supplied with current, only when a selection process is being carried out. Aside from switchings, the locking unit prevents an unintended displacement of the sliding sleeve.

[025] The selector unit 20 has two magnet coils 22, 23 between which an armature 24, designed as an annular part, is axially movably disposed. With the armature 24 are coordinated one left armature counterpart 25 and one right armature counterpart 26, respectively, in the area of the left magnet coil 22 and of the right magnet coil 23. The armature 24 is fixedly connected with the outer ring of the grooved ball bearing 24, that is, the axial motion of the armature 24 is transmitted directly to the sliding sleeve 14. Herebelow is described the exact structure of the selector unit 20.

[026] Fig. 2 shows in enlarged representation of the selector unit 20 of Fig. 1, the reference numerals of Fig. 1 having been adopted. The left magnet coil 22 substantially quadratically designed in cross-section and the right magnet coil 23 rectangularly designed in cross-section are accommodated and held together by a magnet body 27 consisting of three joined parts 27a, 27b, 27c. This results via the fastening bolts 21 (shown in Fig. 1), which are plugged through a piercing hole 28 of the magnet body 27. On the magnet body 27 are, likewise, fastened the two armature counterparts 25 and 26. The armature 24 of annular design has one right outer slope 24a and one left inner slope 24b, that are, respectively, conical annular surfaces. The right armature counterpart 26 has a corresponding

slope 26a and the left armature counterpart 25 has a corresponding slope 25a, that are, likewise conical annular surfaces. The angle α of said armature slope or of the cone amounts to about 3 degrees. The armature slope 24a is limited in direction of the armature center by a front surface 24c while the armature slope 24b terminates on an inner front surface 24d. These two front surfaces 24c, 24d, extending perpendicular to the axis of rotation, serve as a stop in the axial motion of the armature 24. The switch stroke covered by the armature 24 between the two switch positions is designed with x. The air gap is minimized by the armature slopes 24a, 24b and the corresponding slopes 26a, 25a on the armature counterparts 26, 25, thereby resulting a substantially constant course of the magnetic tightening force upon the armature 24.

[027] The selector unit 20 operates so that either the left magnet coil 22 for movement of the armature 24 to the left or the right magnet coil 23 for movement of the armature 24 to the right is supplied with current. By virtue of the above mentioned constant traction flow, there immediately results, upon a reversal, the full magnetic tightening force upon the armature 24.

[028] Fig. 3 shows a representation in perspective of the above described selector unit 20 as a complete front-mounted structural unit 30 in two representations with different switch positions. The left figure corresponds to the representation in Fig. 2, that is, the armature 24l is in its left position. The right figure, on the other hand, shows the armature 24r in its right position. The selector unit, shown in Fig. 2, is completed by the bearing 19 and the selector sleeve 14. Together with the magnet coils 22, 23, the armature 24 and the magnet body 27, these parts result together in the compact structural unit 30 introduced as such in the gear set shown in Fig. 1 and fastened there. From the representation can be easily noted that the sliding sleeve 14 is encased and thus cannot cause much churning losses.

Reference numerals

1 planetary gear set
2 input shaft
3 output shaft
4 housing cover
5 housing cover
6 transmission housing
7 driving sleeve
8 sun gear
9 planetary gear
10 planet carrier
11 ring gear
12 outer coupling gearing (part 11)
13 inner coupling gearing (part 14)
14 sliding sleeve
15 outer coupling gearing (part 7)
16 outer coupling gearing (part 14)
17 inner coupling gearing (part 18)
18 brake disc
19 grooved ball bearing
20 selector unit
21 fastening bolts
22 magnet coil, left
23 magnet coil, right
24 armature
24a armature slopes
24b armature slopes
24c front surface
24d front surface
25 armature counterpart, left
24a slopes (part 24)
26 armature counterpart, right
27 magnet body
27a magnet body
27b magnet body
27c magnet body
28 through hole
29 electromagnetic actuating unit
30 front-mounted structural unit